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EXPLOSIVES-HANDLING PRACTICES AT THE MINES OF THE ANACONDA COPPER MINING CO. AT BUTTE, MONT.

BY

EDWARD F. COURTNEY AND JOHN A. JOHNSON

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EXPLOSIVES-HANDLING PRACTICES AT THE MINES OF THE ANACONDA COPPER MINING CO. AT BUTTE, MONT.[1]

By Edward F. Courtney[2] and John A. Johnson[3]

INTRODUCTION

Loss of life, loss of sight, crippling injuries, and property damage nearly always result from accidents involving explosives. The severity of such accidents has prompted lawmaking bodies to pass laws concerning the transportation, handling, and use of explosives; manufacturers of explosives publish manuals describing explosives and practical methods of handling them; and mining companies and others who use large quantities of explosives publish rules based on actual experience for the guidance of their employees.

Careless storage of explosives by thoughtless or incompetent persons, particularly if they are left where children or saboteurs have access to them, has led to many serious accidents. Many contractors and mining operators who use explosives are extremely careless about storing them. It is the purpose of this paper to discuss the explosives-handling practices of a large western mining company, which are considered better than most.

TRANSPORTATION AND STORAGE

Surface Storage of Explosives and Detonators

Supplies of explosives and detonators are obtained weekly from well-constructed storage magazines owned and maintained by one of the leading manufactures of explosives in the United States. These magazines are on a railroad spur about 10 miles from the mines operated by the mining company. Neither detonators nor explosives are stored on the surface at any of the properties of the company, except the current supply of detonators and capped fuses stored in the fuse-capping stations at the mines.

Surface Transportation of Explosives and Detonators

Detonators are hauled once each week by motortruck from the main detonator-storage magazine to the mines, where they are placed in substantially

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constructed, portable wooden boxes for transportation to the underground storage magazines maintained at each mine.

Explosives are delivered once each week by rail from the main explosives-storage magazine to a central location in the mining area. The cases of dynamite are removed from the railroad cars and are loaded onto motortrucks for distribution to the operating mines. When the loaded motortrucks enter a mine yard, all hoisting ceases, and it is not resumed until all the cases of explosives have been taken to the underground magazine.

Trucks are manned by crews consisting of a driver and a "swamper", who are chosen for their reliability. Motortrucks are maintained in good mechanical condition. Their bodies, which are painted a bright, distinctive color, are lined with wood, and signs bearing the words EXPLOSIVES-DANGEROUS in white letters 6 inches high on a red background are placed on the endgate and both sides of each truck. In addition, a fire extinguisher and a large red flag are carried on each truck. The flag, with the word DANGER in white letters 6 inches high, is prominently displayed on the truck.

Surface Fuse Cutting and Capping Stations

Fuses are "capped" on the surface in a separate room provided for that purpose. (See fig. 1.) Material other than reels, each of which contains 3,000 feet of safety fuse, and the daily supply of detonators are not stored in this room. Doors are locked in the absence of a licensed attendant, windows are protected by substantial metal screen or metal bars, and warning signs indicating the contents of the magazine are posted on the premises.

Detonators are obtained daily from the underground detonator-storage magazine, and detonators left over at the end of the shift are placed in a locked box-type storage magazine kept in the fuse-capping room. Daily inventories are taken of capped fuses stored underground, and only enough capped fuses to satisfy current needs are made up each day.

Standard lengths of capped fuses are supplied. These are cut from reels of fuse mounted on spindles by means of a combination cutter and cap crimper equipped with a foot treadle, which makes it possible to cut five strands at a time. To avoid kinking the fuse, rolls that contain 25 capped fuses are prepared for transportation underground, and a tag showing the date, length of fuses, and destination is fastened to each roll. As a precaution, caps are placed inside the rolls.

The uncapped ends of fuses are dipped in white paint when they are prepared at the fuse-capping station. This enables the miner to identify cut fuses, so that the same fuse will not be cut twice when trimming them for rotation in blasting.

Transporting Explosives from the Surface into the Mine

Detonators and explosives are not transported together. Rolls of capped fuses to be taken underground are placed in substantial boxes constructed of 2-inch wood and provided with hinged lids and fiber rope handles. All metal

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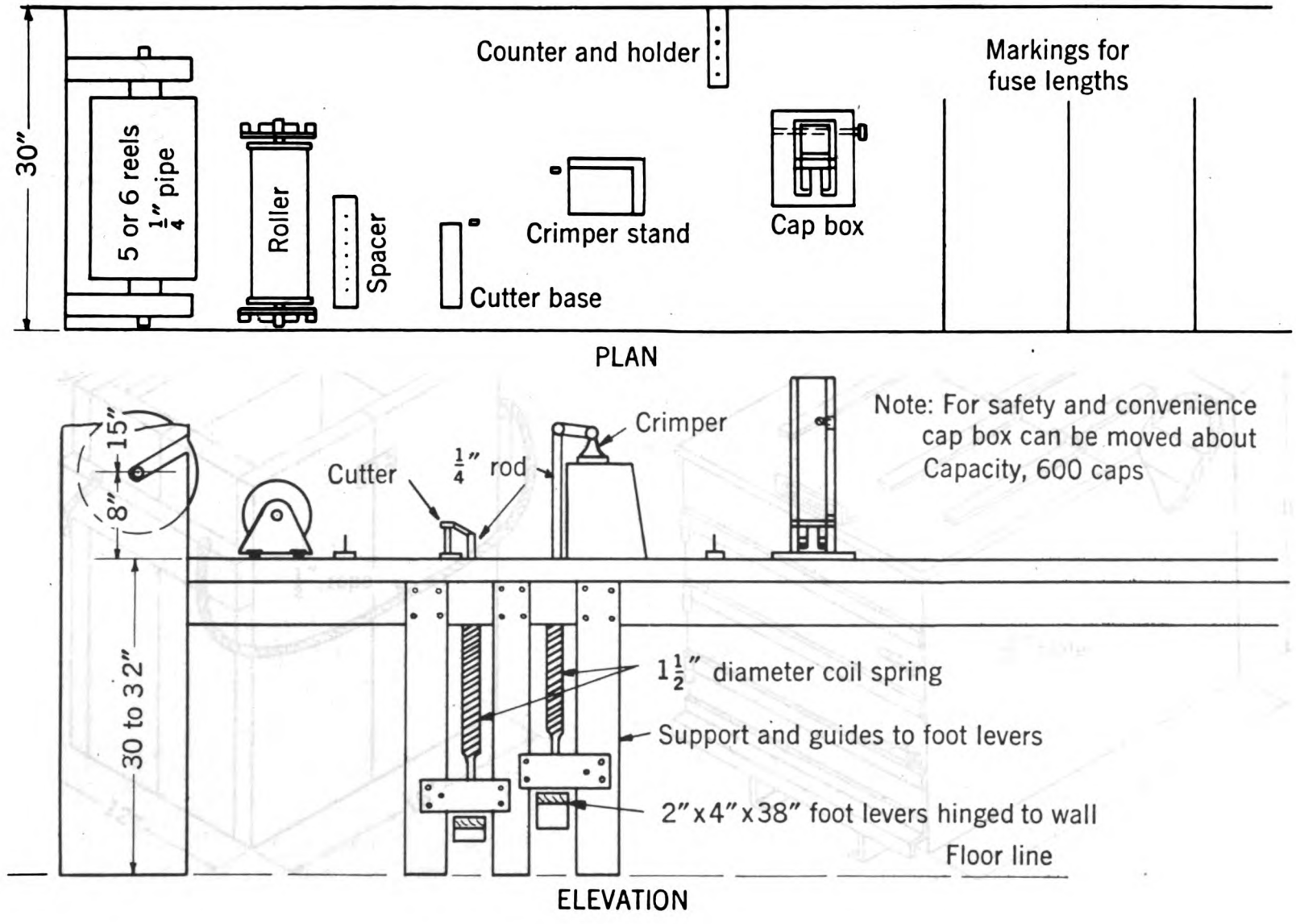

Figure 1. - Surface fuse cutting and capping station. (Courtesy Engineering and Mining Journal, May 1939.)

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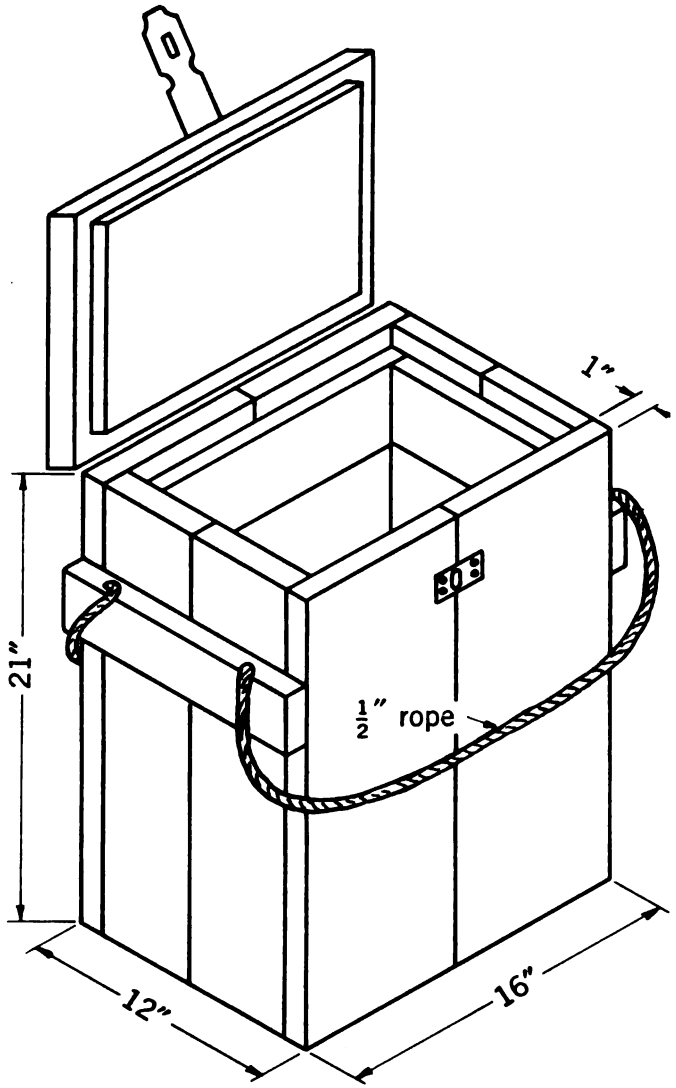

Figure 2. - Wooden box for transporting electric detonators, detonators, and capped fuses from the surface into the mine.

Dimensions	Maximum outside	Inside
l	3'4"	3' 2"
w	2' 3"	2' 1"
h	2' 9"	2'7"

Total height above rails when mounted on truck 4'

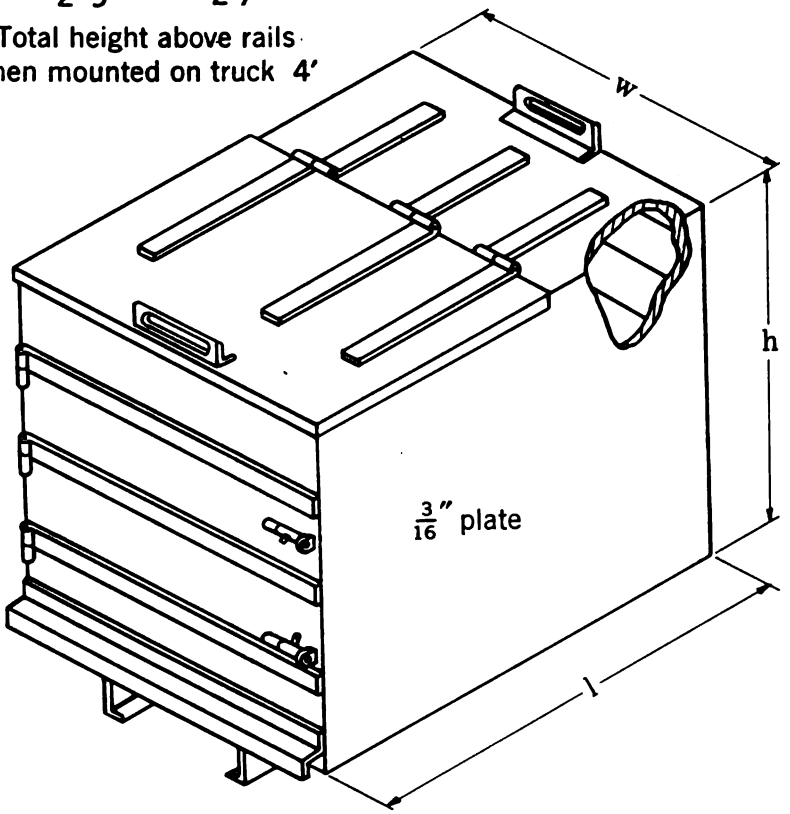

Figure 3. - The body of the wood-lined steel car used to transport explosives from the surface into the mine. (Courtesy Engineering and Mining Journal, May 1939.)

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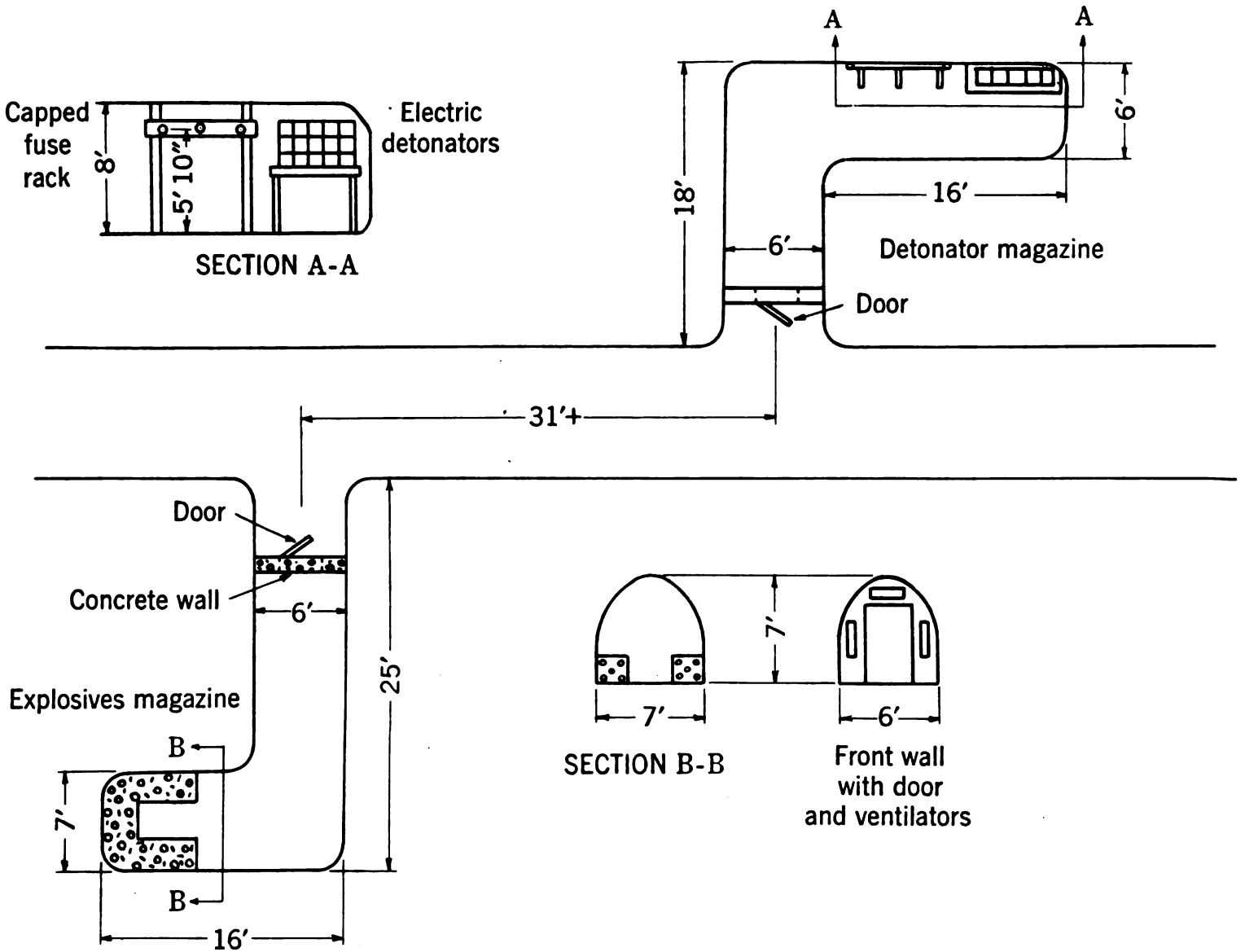

Figure 4. - Typical L-shaped explosives- and detonator-storage magazines provided underground.

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used in the construction of the boxes is concealed. Electric detonators are transported in the same manner. (See fig. 2.)

Enclosed cars of standard gage, constructed entirely of steel and lined throughout with wood 1 inch thick, are used exclusively for transporting dynamite from the surface to the underground explosives-storage magazines. These cars are equipped with hinged lids; also, one end of the cars is provided with a hinged door, which makes them readily accessible and minimizes the possibility of workmen dropping cases of explosives. Fastenings are provided on the lids and doors so that the cars can be securely locked while in transit. (See fig. 3.)

Mine cages travel slowly when explosives are being transported in the shafts, and persons are prohibited from riding on them.

Transportation from the Shaft to Underground Storage Magazines

Designated employees underground who are licensed under the Federal Explosives Act are responsible for the delivery of capped fuses, electric detonators, and explosives from the shaft to the storage magazine.

Electric detonators are obtained from the main underground detonator-storage magazine as needed, transported to the level where they are to be used in the wooden box provided for that purpose, and stored in the level capped-fuse magazines. Capped fuses and electric detonators are transported manually from the shaft to the magazines.

If possible, the cars in which explosives are lowered into the mine are hand-trammed to the storage magazines. If the distance to be traveled is long, the explosives car is attached to a train of three empty cars by means of an insulated coupling and is transported to the distributing magazine by a storage-battery locomotive.

Underground Storage or Distributing Magazines

The site for an explosives-storage magazine underground is chosen with regard to various influencing factors. It must not be too far from working places in the mine, and it must be in firm ground and so situated that accidental explosion of the contents of the magazine would not endanger the lives of workmen employed in the mine nor close the exit from the mine.

Standard explosives-storage magazines are L-shaped (see fig. 4), and near the front of the "L" an 8-inch concrete wall is placed, in which an opening is left for a doorway. This opening is fitted with a heavy steel door securely anchored to the concrete frame by means of heavy, bolted hinges. Screened ventilation openings about 8 by 12 inches in size are provided in the concrete wall on each side and at the top of the doorway.

One week's supply of explosives, which rarely exceeds 2,000 pounds, is stored in the offset chamber of each magazine on a raised concrete or rock shelf.

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Magazines in which capped fuses and electric detonators are stored (see fig. 4) are separated from the explosives-storage magazines by a distance of at least 25 feet. These magazines are provided with a front wall of concrete similar to that on explosives-storage magazines, or with a wooden front wall of at least 2-inch material. All wooden sections of the magazine are covered with expanded metal lath and gunite, with the exception of the wooden racks provided to support the fuses. Electric detonators are stored in compartments in wooden boxes in the fuse magazine; the delay number of the various electric detonators is marked on the storage compartments, and the length of capped fuses is indicated on racks where they are stored. Fuses are hung on the racks so that they do not touch the floor or become kinked. Four hundred capped fuses is the maximum stored in any magazine.

Automatic sprinkler heads are installed in all detonator- and explosives-storage magazines, and warning signs and NO SMOKING signs are posted at each magazine; also, signs are provided that state the hours during the shift when an attendant will be present to issue explosives, for the magazines are locked when the attendant is not present.

Transportation of Explosives from Underground Magazines to the Faces

Where a large quantity of dynamite is used in blasting a round of holes, such as in a drift, the dynamite is delivered to the working face in mine cars. The cases of dynamite are protected by planks placed on the bottoms and on top of the cars.

Canvas sacks 22 by 12 by 4 inches, with slings that fit over the shoulder, are provided workmen for transporting explosives and capped fuses from magazines to the working faces of stopes and raises.

Capped fuses and electric detonators are always transported manually, and the practice of placing these articles in containers with dynamite is prohibited. It is required that dynamite and detonators be kept separated at the working faces while holes are being loaded.

Wooden mallets and wooden wedges are used when opening cases containing explosives.

DRILLING AND BLASTING

Methods of Drilling Rounds

All drilling is done "wet".

Standard rounds have been developed for various types of headings. The V-cut round is most common, although at times other types, including the "burn" cut, are drilled.

Three types of pneumatic rock drills are used. Self-rotating stopers, commonly known as "buzzies", are used for drilling rounds in stopes and raises and for other miscellaneous drilling where it is necessary to drill holes

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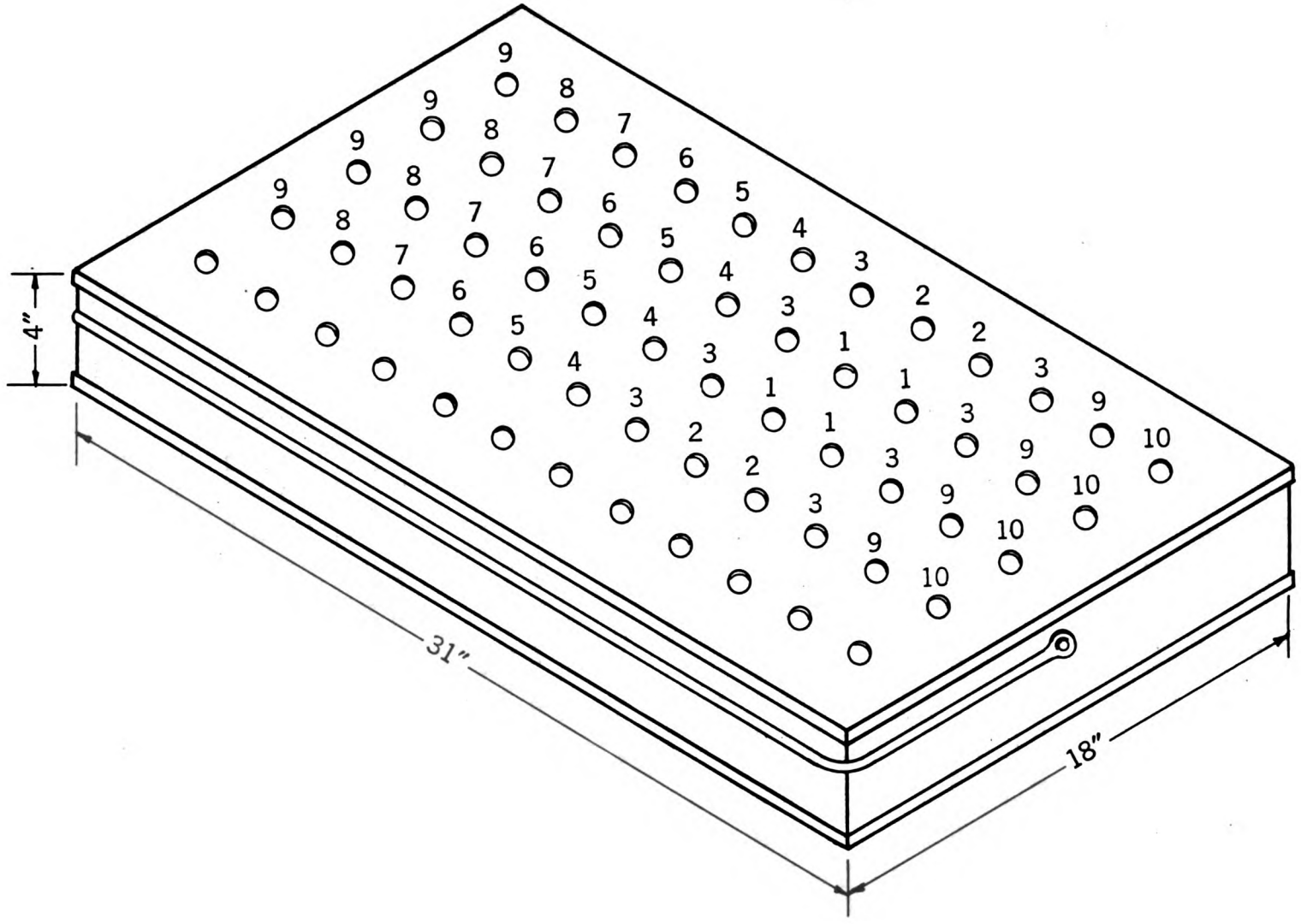

Figure 5. - Sixty-hole template or rotation box used to transport primers for a 48-hole shaft round. Firing order of holes as indicated. Primers for plugholes are carried in the extra row of holes.

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upward; drifters, or "Leyner's", are used for horizontal drilling, such as is done in drifts and crosscuts; and jackhammers are used for down-hole work, such as is done when sinking shafts. A reverse-feed drill, which is a stoper equipped with a base from which a piston operates inside the feed leg that forces the machine up against the ground, is sometimes used in horizontal headings of small cross section; it is also used in stopes where nearly horizontal holes are drilled, such as in horizontal cut and fill stopes. The reverse-feed machine is either mounted on an arm attached to a pneumatic vertical bar or to the vertical bar by means of a universal coupling. The reverse-feed machine can also be used as a stoper, in which case it is not mounted on a bar.

Drifters used for drilling in headings 7 by 5 feet, or less, in cross section are usually mounted on an arm attached to a vertical bar; and those used in headings of larger cross section usually are mounted on a portable drill carriage that supports two drills. Both hand- and automatic-feed machines are used, but automatic-feed machines are replacing hand-feed machines as the latter type wear out and are discarded.

When holes are to be about 6 feet deep, a detachable bit 2 inches in diameter is used to start them, and they are finished with a bit 1-½ inches in diameter. Bits of five sizes are used, each size being 1/8 inch smaller in diameter than the preceding one. Shallower holes, unless drilled in very hard rock, require fewer changes of bit.

Preparation of Primers Used in Blasting

A primer consists of a dynamite cartridge in which a capped fuse or electric detonator has been inserted. When the primer is assembled, standard practice requires that a hole be punched in the end of a dynamite cartridge with a wooden tool and that the detonator be inserted in the center of the section of the cartridge and parallel to its long axis. Lacing fuse or wires through the primer cartridge and the use of more than one primer in each hole are prohibited.

All primers are prepared at the working faces, except those used in blasting round drilled in shaft bottoms. Blasting in shafts is accomplished with electric detonators in delays from 1 to 10, inclusive; instantaneous electric detonators are not employed. Shaft rounds are drilled in a specified manner, and primers for use in these rounds are prepared in a safe place on a level of the mine above the point where shaft sinking is going on. A wooden template, known locally as a "rotation box", constructed of 1-inch dressed lumber is provided; as primers are prepared, they are placed in holes in the template corresponding in position to holes in the shaft round. This template, which is in the form of a carrier, is used to transport the primers to the bottom of the shaft (see fig. 5.) Smaller templates of a similar pattern are provided for use in electric blasting in other type openings.

Cap and Fuse Blasting

Usually, holes are drilled to a depth of about 6 feet. The primer is placed directly on the bottom of the hole; an extra stick of dynamite to act

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as a cushion is not placed ahead of the primer in the hole, for this is considered unsafe. The required amount of dynamite, which has been determined by the boss on the beat, is inserted in each drill hole after the primer has been placed.

The dynamite cartridges (with the exception of the primer cartridge) are slit, unless perforated cartridges are used, so that when loaded into a hole the dynamite may expand and completely fill the hole. Wooden tamping sticks are provided. Fireproofed cotton stemming is available but is not used extensively, for its use is not mandatory at all working faces. Space blasting is not universally practiced, but at times it is employed.

A semi-gelatin dynamite of 45-percent strength is generally used, although dynamites of 40-percent and 20-percent strength are provided and used where conditions warrant. Safety fuse having a burning rate of about 1 foot in 40 seconds and No. 6-strength detonators are used. A placard showing the burning rate of fuse is posted at each capped-fuse magazine.

After the holes have been loaded, the ends of the fuses are cut to allow for the proper firing intervals, a 2-inch cutoff being used for the interval. Bunch blasting is standard practice; usually about half of the fuses, but not more than 15, are tied in one bunch and the remainder in another bunch, depending on the number of holes to be blasted. Care is taken to even the ends of the fuses when they are bunched, and wrapping or strands taken from the discarded ends of fuses is used to tie the bunches. After the fuses have been bunched, the ends of each bunch are cut off with a special fuse cutter, so that a fresh surface of powder is exposed.

A spitter made from a discarded fuse cut from one of the fuses in the round is used to ignite the first bunch of fuses. After one bunch is started, it is held close to another bunch, which in turn is ignited. The bunches are rotated slightly, so that the fuses spitting back and forth ignite each other. (See fig. 6.)

Electric Blasting

Blasting is done by means of electricity in all wet places, drifts, and crosscuts, and in special operations such as shaft sinking. It is company practice to utilize electric current for blasting; however, in isolated places, where it would not be feasible to install power lines, a blasting machine is used. Wires are connected in series when a blasting machine is used and in parallel when electric current from a power line is used.

A suitable transformer is used to step the 440-volt current down to 110 volts where only 440-volt current is available. The transformer is installed in the power line in series with a cut-out switch on the 440-volt side, and with the blasting switch (which is enclosed in a box provided with a lock) on the 110-volt side; and the entire installation is grounded. Fuses are provided in the power line on both sides of the transformer to guard against an over supply of power. The blasting box, which

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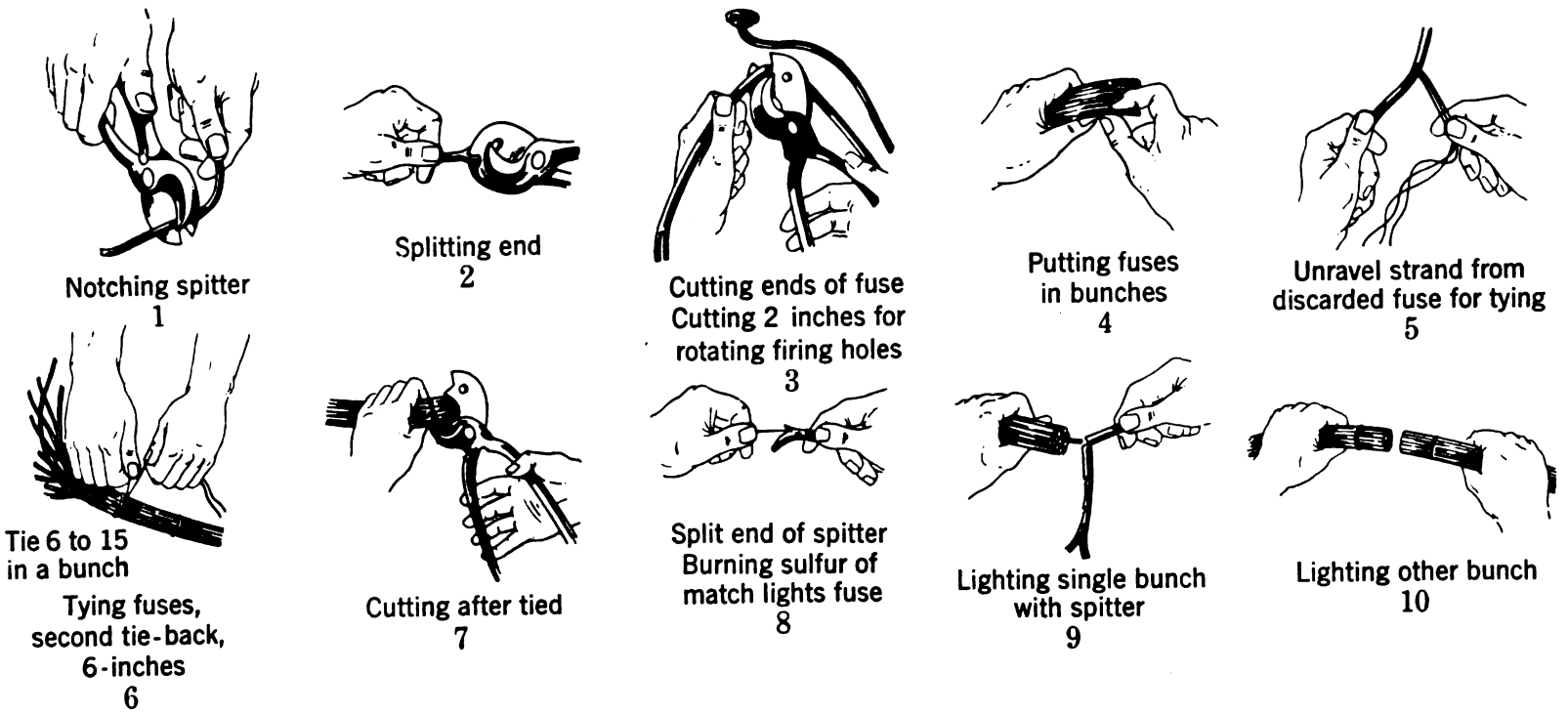

Figure 6. - Steps taken in preparing fuses of a round for bunch blasting. (Courtesy Engineering and Mining Journal, May 1939.)

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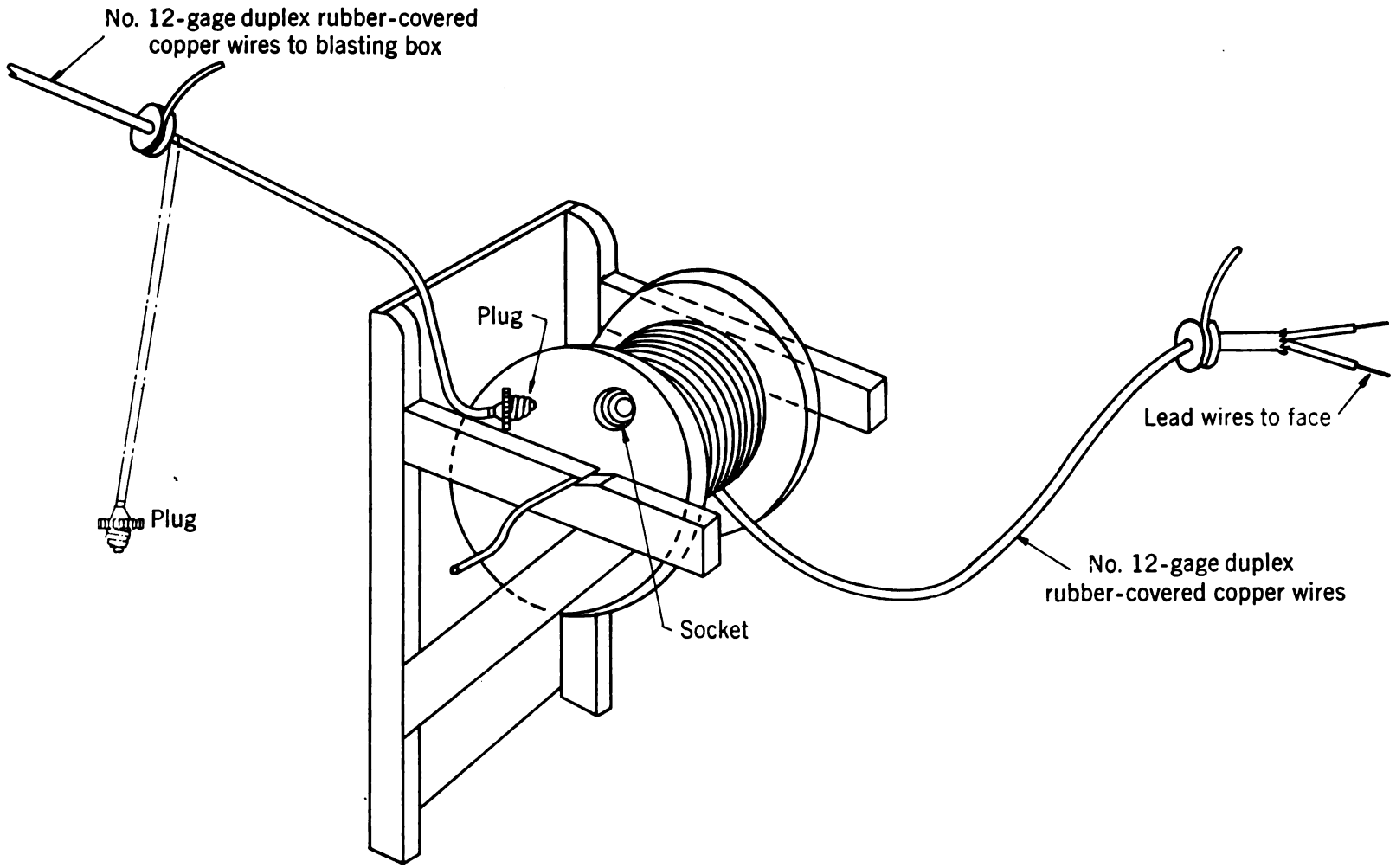

Figure 7. - Blasting reel adaptable for use in connection with electric blasting in any type opening.

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is constructed so that the switch remains in the open position when the door is closed, is kept locked except when blasting is being done, and the key is in possession of the person in charge of the blasting. The blasting station is some distance from the face to insure safety to the man who operates the switch.

The lead wires are No. 12 gage, duplex, rubber-covered copper wires that extend from the blasting switch to a blasting reel capable of holding 300 to 500 feet of wire. The reel is mounted on brackets in a manner that permits advancing the lead wires to the blasting face, for a section of the ends of the blasting wires is destroyed with every blast. The lead wires between the blasting switch and the blasting reel terminate at a threaded plug, which must be inserted into a threaded socket placed in one end of the blasting reel to complete the connection with the lead wires extending from the blasting reel to the face. The plug must always be removed from the socket in the reel before the lead wires are advanced to the face to be attached to the detonator leg wires. This arrangement serves the same purpose as a safety switch and also provides an air gap in the blasting line. (See fig. 7.)

Company policy requires that all blasting done by means of electricity must be under the supervision of a competent person, and all workmen employed at this work must be thoroughly schooled in the practice.

Method of Handling Missed Holes

Miners and supervisors receive definite instructions concerning the method of detecting and blasting missed holes. They are instructed that the first thing to do upon entering a working place after a blast is to make the place safe to work in. Then the back, walls, and face must be examined to determine whether or not any holes were missed. This is accomplished by thoroughly washing the face where the blast was detonated, including all bootleg holes. Company rules state that drilling in bootleg holes is forbidden, and drilling operations must not be conducted in the vicinity of a missed hole. Company safety rules forbid the removal of capped fuse, dynamite or stemming from a missed hole. Misfires are reblasted by inserting another primer in the missed hole.

Miners are instructed to count the number of reports from each round and to report to their shift boss the number of holes that misfire. The shift boss apprises his partner of the location and number of misfires and also records the information on a bulletin board on the shaft station of the level on which the misfires occurred, so that the oncoming shift may know about it and be on the alert for missed holes. This is an additional precaution, for shift bosses are required to notify miners of any misfires at their working face before the miners leave the surface to go underground.

When it is necessary to blast during the shift, and if any misfires occur, workmen are prohibited by company rules from entering the working place until at least 30 minutes have elapsed from the time the shots were fired. Company safety rules require that when miners blast a missed hole

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containing the primer from the previous blast, not less than 15 minutes should elapse before the working place is entered, for the old charge is likely to delay in detonating. Experience has shown that in a few instances the new primer failed to detonate the old charge but ignited the fuse from the previous charge, which continued to burn until the old primer was detonated.

The method of handling missed holes in fuse blasting applies to electric blasting, also.

MISCELLANEOUS

Miscellaneous Practices Relating to Use of Explosives

When blasting is done, supervisors make plans to blast the working places in rotation, so that workmen leaving at the end of the shift will travel through a minimum of fumes. All approaches to places where blasting is being done are guarded; and when working places approach each other, or when workings are about to be connected, blasts are made only at prearranged times. When blasting is done in or near the shaft, the hoisting engineer is notified both before and after the blast, either by telephone or by a prearranged signal given on the signal line. Cages are not run past points in or near the shaft where blasts are made until the "all-clear" signal has been given to the engineer.

Licensed Magazine Keepers

All employees responsible for the custody or distribution of explosives have been licensed as required by the Federal Explosives Act.

Distribution and Records of Transactions in Explosives

Distribution

When a shift boss visits a working place on his regular round, usually during the latter part of the shift, he fills out a printed form in duplicate; he retains the carbon copy and presents the original of the form to the miner working in the place in which blasting is to be done. The following information is recorded on the form: the location of the working place, the date, number of holes to be blasted, amount of dynamite needed, and the signature of the boss. The miner presents his copy of the form to the magazine keeper, who issues the required amounts of material. This requisition slip is retained by the magazine keeper and given the timekeeper at the mine office at the end of the shift.

Detonator Records

The number of detonators received weekly is recorded on forms in the office and the fuse-capping station. The attendant at the surface fuse-capping station records the number of detonators delivered to the mine weekly, the number delivered to him daily from the main underground magazine,

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Figure 8. - Bulletin board in mine yard.

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the number and lengths of capped fuses prepared, the location of the magazine to which capped fuses are delivered daily, the number of capped fuses on hand in the fuse-capping station at the beginning and end of the shift (fuses are capped on the day shift only), and the number of detonators on hand in the fuse-capping station at the end of each shift.

The underground magazine keepers maintain a record of capped fuses or electric detonators used underground daily.

Explosives Records

At the end of the night shift preceding the day on which explosives are to be ordered, it is determined from the underground magazine keepers' daily inventory of explosives on hand in each magazine in the mine the amount of explosives to be ordered for use during the following week. A complete record is kept of all transactions in explosives, both in the mine office and at the magazines. The total amount of explosives received weekly and the amounts delivered to the various levels in the mine are recorded in the office. The underground magazine keepers maintain records of the amount of explosives on hand at the beginning of the shift; the amount received during the shift, if any; the amount issued daily to each working place; and the amount of explosives on hand at the end of the shift. These records, kept at the magazines, are recorded permanently in the office. An additional record of explosives is kept by the shift boss, who enters on his daily cost sheet the amount of explosives and the number of capped fuses or electric detonators issued to each working place.

The name of the working place or the contract number of the working place only is recorded on these records. The names of individual workman to whom explosives are issued are not recorded, but these names can be obtained readily by referring to the book in which the record of time is kept, for the names of all men working in each contract are recorded in the time book.

SAFETY ORGANIZATION

An active safety organization headed by the chairman of the bureau of safety is maintained by the company. A full-time safety engineer is employed at each of the operating mines. A safety committee composed of the chairman of the bureau of safety, safety engineers, and other supervisors meet regularly and discuss safety problems as they arise. Safety engineers make daily inspections, both on the surface and underground, and submit reports daily to the mine foreman and biweekly to the bureau of safety, with recommendations to the manager of mines through the chairman of the bureau of safety concerning existing accident hazards noted during the time of these inspections. Ways and means of correcting existing hazards are discussed at the safety meetings.

An attractive bulletin board is provided at a prominent location in the mine yards, and safety posters are changed regularly. (See fig. 8.)

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COMPANY SAFETY RULES

The following rules concerning transportation, handling, and use of explosives are taken from a pamphlet published under the supervision of the bureau of safety of the Anaconda Copper Mining Co. A copy of this pamphlet is furnished to all employees of the company who work underground.

Rules for the Prevention of Personal Injuries Due to Handling or Using Explosives.

246. Smoking and open flames are prohibited in any powder or fuse magazine and while handling powder and primers.

247. When powder is delivered to any mine, all hoisting must cease. The powder must be placed in powder cars at once and immediately lowered to the respective levels and tramned to underground magazines.

248. When new powder is brought in, powder remaining in magazines must be moved to the front, where the earliest-dated powder can be used before new powder is opened.

249. Powder and fuse magazines must be plainly marked by an approved sign and must be located at least ten feet from and out of direct line of any haulageway. They must be dry and well-ventilated and must not be located under old stopes or raises or in other fire-hazardous places, or where accidental explosion is likely to close an exit and thus prevent the escape of men from the mine. They must be equipped with automatic sprinkler-heads, and the water supply to these must be kept turned on at all times.

250. Each powder house is to be supplied with a wooden mallet and wooden wedges for opening boxes of powder.

251. All powder and fuse magazines must be made fireproof.

252. Entrances to powder and fuse magazines must be kept free from slipping and tripping hazards and debris.

253. Fuse magazines must be provided with pegs having the length of the fuse on each peg plainly marked. A box must be provided at each fuse magazine in which all cut-off or rejected blasting caps shall be kept until they can be destroyed.

254. Rejected powder and blasting caps must be taken out of the mine and destroyed in an approved manner.

255. Powder for stopes and raises must be carried in powder sacks, and loose powder must not be carried without a sack.

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256. Powder or blasting caps must not be left in any place about the mine except in regular magazines.

257. All fuses must be cut and capped at surface fuse-capping plants, marked for length, and sent underground in covered, wooden boxes provided for this purpose. Capped fuses transferred from one level to another shall be carried in the regular box.

258. All capped fuses must have uncapped ends dipped in white to enable the miner to identify cut fuses.

259. In all places where fuse blasting is done, bunch blasting is the standard practice required for drifts, cross-cuts, raises, and stopes.

260. Primer cartridges must be made up at the working face.

261. In making primer cartridges, the blasting cap must be inserted into the end of the powder stick to avoid possibility of the cap rubbing against sides of the hole, and lacing of the fuse through the powder stick is prohibited.

262. A spitter must be used in all fuse rounds blasted.

263. The practice of double priming is prohibited.

264. Electric blasting must be used in all sinking work and in all wet sills.

265. Do not use a defective powder sack.

266. Do not blast without giving proper warning and guarding all approaches.

267. Do not leave powder and blasting caps together at the face while loading. Keep them separated, and be sure there are no loose rocks overhead while making up primers.

268. Do not carry capped fuse and powder together in the same sack.

269. Bosses must notify miners when they are close to holing other workings, and men working therein must be warned of blasts in time to get away from danger.

270. In the loading of holes, use only wood tamping sticks in good condition and avoid tamping by strokes. The primer cartridge must be placed in the bottom of the hole. Do not use a cushion stick ahead of the primer cartridge.

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271. Miners must count their shots and report any missed holes to a designated person when going off shift.

272. Miners must examine the back, breast, and face for missed holes. Working places with missed holes must not be entered for at least thirty minutes from the time of spitting reblast. Missed holes must be reblasted before any drilling is done in proximity to the missed hole. Do not dig powder from a missed hole, but insert another primer and fire it.

273. When a blasting cap remains in a missed hole, give it extra time after reblasting. The old charge is liable to delay.

274. Drilling in bootlegs is prohibited.

275. Noon-time blasting should occur only when absolutely necessary.

276. In electric blasting, the lead wires must be run from a switch box equipped with a padlock for which only one key is available, and this key must be in the possession of the man who connects the blasting cap wires.

277. The switch box must be so arranged that the door cannot be closed with the switch in the "power on" position, and the box must be kept closed and locked at all times except when in actual use by the blaster. See that the plug is removed from the reel before loading the round.

278. Each individual place using electric blasting must have a separate blasting box.

279. Each blasting cap must have the wires short-circuited by twisting the ends together, and they must remain so until just before they are connected to the lead wires.

280. Connection of blasting cap wires to lead wires must be made by first scraping both wires, then wrapping the detonator wire firmly around the bare, cleaned lead wire, and bending the lead wire back to form a loop and taking another twist around the loop, where possible, to form a strong connection.

281. Miners working in drifts and stopes are required, as one of their first duties, to thoroughly wash the face previously blasted, and wash out all bootleg holes.

282. Powder or primers shall not be placed on a motor for the purpose of being moved from one place to another.

283. Blasting switch boxes must be so placed that no one can enter from another place between blasting box and the face being blasted.

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284. When blasting is done in skip chutes or near the shaft, the engineer must be notified by telephone or a blasting signal.

285. When blasting in or near crosscuts or drifts having electric wires or cables, suitable covering material must be placed around such wires or cables to prevent breaking the insulation.

COMPARISON OF EXPLOSIVES ACCIDENTS WITH OTHER ACCIDENTS

Table 1 is a comparison of explosives accidents with accidents from other causes at the Butte mines of the company during the 5 years from 1940 to 1944 and in metal and nonmetal mines in the United States during the period 1940 to 1942. The figures for the United States do not include accidents at open-cut mines.

TABLE 1. - Comparison of explosives accidents with accidents from other causes

	Percent of grand total			
	A. C. M. Co., 1940 to 1944		United States, 1940 to 1942	
Cause of accidents	Fatal	Nonfatal	Fatal	Nonfatal
Explosives accidents.....	1.01	.54	9.39	.64
All other causes.....	98.99	99.46	90.61	99.36
	100.00	100.00	100.00	100.00

CONCLUSIONS

Explosives-handling practices as followed by the Anaconda Copper Mining Co. at Butte are the result of many years' study concerning the subject. About 3,985,447 pounds of explosives, 27,015,780 feet of safety fuse, 2,013,656 detonators, and 126,894 delay electric detonators were used during 1944. The fact that only 1.01 percent of the fatal accidents that occurred during the years 1940 to 1944, inclusive, at the mines of the company in Butte were caused by explosives, compared with 9.39 percent for the United States during the years 1940 to 1942, inclusive, as shown in the above table, indicates that skill in handling explosives has been developed to a high degree by the company officials.

ACKNOWLEDGMENT

The authors gratefully acknowledge the assistance given by J. A. O'Neill, assistant research engineer, who furnished sketches and the copy of the Engineering and Mining Journal to which reference is made in this article; H. J. Rahilly, general superintendent of mines; Lester Bishop, general production foreman; J. L. Boardman, chairman, bureau of safety; and C. Kerlee, foreman of the electrical shop, all with the Anaconda Copper Mining Co., Butte, Mont., in furnishing the information contained in this paper.

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